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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H04M 11/00

A1

(11) International Publication Number: WO 92/10046

(43) International Publication Date: 11 June 1992 (11.06.92)

(21) International Application Number: PCT/US91/06583

(22) International Filing Date: 11 September 1991 (11.09.91)

(30) Priority data:
620,780 3 December 1990 (03.12.90) US

(71) Applicant: LIGHT IDEAS INCORPORATED [US/US]; 6345 Balboa Boulevard, Suite 175, Encino, CA 91316-1517 (US).

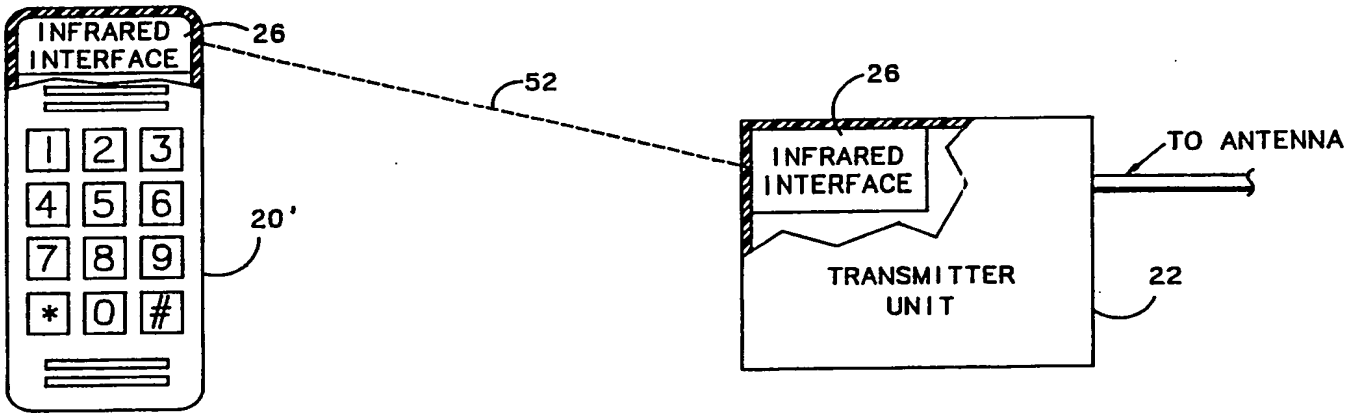
(72) Inventors: BARKER, Michael, L. ; 664 Brook Park Drive, S.W., Calgary, Alberta T2W 2R1 (CA). SENDYK, Andrew ; 156 Parkland Green, S.E., Calgary, Alberta T2J 3X6 (CA). IGGULDEN, Jerry, R. ; 21600 Cleardale Street, Newhall, CA 91321 (US). STRECK, Donald, A. ; 832 Country Drive, Ojai, CA 93023 (US).

(74) Agents: DAVIS, Anthony, G., M. et al.; Davis, Bujold & Streck, 175 Canal Street, Manchester, NH 03101 (US).

(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU+,TD (OAPI patent), TG (OAPI patent).

Published
With international search report.

(54) Title: LIGHT-LINKED CELLULAR TELEPHONE



(57) Abstract

A cellular telephone system wherein the handset (20') thereof is connected to the remaining portions (22.92) by an infrared light-link (26). This provides the elimination of the connecting cord with attendant benefits, principally the ability to roam with the handset in the manner of a so-called "cordless" telephone. Various embodied infrared light-links include a through-the-glass version incorporated with the RF antenna and a bi-directional dash-mounted version (figure 6, figure 7) for automobiles (10) which connects to the handset when inside of the automobile or outside thereof; and also a combined IR interface and dome light unit (54) for disguising and hiding the infrared light-link inside of a vehicle.

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LIGHT-LINKED CELLULAR TELEPHONE

Background of the Invention:

This invention relates to cellular telephone systems and, more particularly, to a light-connected cellular telephone system comprising, a handset; a transceiver unit; a transmitting and receiving antenna connected to the transceiver unit; first infrared transmitter and receiver unit means built into the handset for converting electrical signals for the transceiver unit into emitted infrared light signals and for converting received infrared light signals as emitted by the transceiver unit into electrical signals; and, second infrared transmitter and receiver unit means connected to the transceiver unit for converting electrical signals for the handset into emitted infrared light signals and for converting received infrared light signals as emitted by the handset into electrical signals.

Cellular telephones have been accepted with great enthusiasm, particularly by business people who are often away from their places of business. With a cellular telephone, they can be in constant communication with their business, customers, and clients in a far more convenient way than with the traditional "beeper". While portable units which can fit into the pocket, purse, or briefcase are available and in use, the vast majority of cellular telephones are installed in automobiles as depicted in Figure 1. Many of the portable units are even adaptable for insertion into an automobile base station for increased power. As is well known, the cellular telephone (not shown) within the automobile 10 is connected to an antenna 12 which is connected by RF energy 14 to a plurality of cells 16 spread throughout the area of coverage. As the automobile 10 moves throughout the area, it is always linked to at least one of the cells 16 so as to transmit out-going calls and receive in-coming calls.

As depicted in Figure 2, the typical prior art cellular telephone system 18 comprises a handset 20 and a transceiver unit

22 which is connected to the antenna 12. The handset 20 is typically connected to the transceiver unit 22 by a self-coiling cord 24. As it turns out, the cord 24 is the highest failure item of the system 18; that is, there is more breakage and failure of the cord 24 from stretching, bending, etc. than any other single component.

Also, the physical connection of the handset 20 to the transceiver unit 22 is as limiting as the connection of the handset of a standard telephone to its base. Thus, the user can only use the telephone when seated in the automobile when it might often be more convenient to be able to move about in the manner of a person using a so-called "cordless" telephone.

Wherefore, it is an object of the present invention to provide a replacement for the cord connecting the handset to the transceiver unit in a cellular telephone system.

It is another object of the present invention to connect the handset to the transceiver unit in a cellular telephone system to the handset with a light link.

It is still another object of the present invention to connect the handset to the transceiver unit in a cellular telephone system to the handset with a link which will allow use of the handset both from within and from outside of a vehicle in which it is installed.

It is yet another object of the present invention to connect the handset to the transceiver unit in a cellular telephone system to the handset with a link which will allow use of the handset in a "roaming" mode.

Other objects and benefits of the invention will become apparent from the detailed description which follows hereinafter when taken in conjunction with the drawing figures which accompany it.

Summary:

The foregoing objects have been achieved in a cellular telephone system comprising a handset connected to a transceiver unit which is connected to a transmitting and receiving antenna, by the improvement of the present invention comprising, first infrared transmitter and receiver unit means built into the handset for

converting electrical signals for the transceiver unit into emitted infrared light signals and for converting received infrared light signals as emitted by the transceiver unit into electrical signals; and, second infrared transmitter and receiver unit means connected to the transceiver unit for converting electrical signals for the handset into emitted infrared light signals and for converting received infrared light signals as emitted by the handset into electrical signals.

In one embodiment, the second infrared transmitter and receiver unit means is contained within a common housing with the transceiver unit.

In another embodiment, the second infrared transmitter and receiver unit means is removed from the transceiver unit and connected to the transceiver unit with a connecting cable. The connecting cable may be an electrical cable or a light pipe. The transceiver unit may also include means for removeably connecting the second infrared transmitter and receiver unit means thereto.

In one variation, the transceiver unit is located within an enclosure and the second infrared transmitter and receiver unit means is mounted outside of the enclosure. In a version of this variation, the enclosure comprises an automobile; and, the second infrared transmitter and receiver unit means comprises, a first portion mounted on an external surface of a glass member of the automobile, a second portion mounted on an internal surface of the glass member of the automobile, wherein signals pass through the glass member between the first portion and the second portion.

In one embodiment, the first portion and the second portion each include a light pipe therein and the signals pass through the glass member between the first portion and the second portion as light signals conducted by the light pipe. The first portion may include means for reflecting incoming light beams from the handset into the light pipe and for reflecting light beams emerging from the light pipe towards the handset.

In another embodiment, the first portion and the second portion each include a capacitive plate adhesively attached to the glass member; the first portion includes means for converting

incoming light beams from the handset into electrical signals applied to the capacitive plate thereof and for converting electrical signals received by the capacitive plate thereof into light beams; and, the signals pass through the glass member between the first portion and the second portion as capacitively-coupled electrical signals.

In a basic aspect, the second infrared transmitter and receiver unit means includes means for converting incoming light beams from the handset into electrical signals output thereby and means for converting electrical signals received from the transceiver unit into light beams output thereby. In one variation of this approach, the means for converting incoming light beams from the handset into electrical signals output thereby comprises at least two light detecting transistors facing in different directions to be responsive to light entering from respective ones of different fields of view; and, the means for converting electrical signals received from the transceiver unit into light beams output thereby comprises at least two light emitting diodes facing in different directions to direct the light beams toward respective ones of the different fields of view.

In one embodiment for special purposes, the second infrared transmitter and receiver unit means is mounted in a common housing in combination with an illumination light producing source whereby the second infrared transmitter and receiver unit means is disguised and hidden within the housing. This unit is convenient for mounting in an automobile headliner.

Description of the Drawings:

Figure 1 is a simplified drawing depicting the prior art environment of cellular telephones as wherein the present invention is particularly useful.

Figure 2 is a simplified drawing depicting the prior art approach of connecting the handset of a cellular telephone system to the transceiver with a self-coiling cord.

Figure 3 is a simplified drawing depicting the approach of the present invention for connecting the handset of a cellular telephone

system to the transceiver with an infrared light link according to a first embodiment.

Figure 4 is a simplified drawing depicting the approach of the present invention for connecting the handset of a cellular telephone system to the transceiver with an infrared light link according to a second embodiment.

Figure 5 is a simplified drawing depicting the approach of the present invention for connecting the handset of a cellular telephone system to the transceiver with an infrared light link according to a third embodiment.

Figure 6 is a detailed, partially cutaway drawing of a combined RF through-windshield antenna connection and exterior IR link-point according to the present invention in a first embodiment thereof.

Figure 7 is a detailed, partially cutaway drawing of a combined RF through-windshield antenna connection and exterior IR link-point according to the present invention in a second embodiment thereof.

Figure 8 is a detailed, partially cutaway drawing of a combined interior light and IR link-point according to the present invention for installation in the headliner of an automobile.

Figure 9 is a detailed, partially cutaway drawing of a combined interior/exterior IR link-point according to the present invention for installation on the dashboard of an automobile.

Figure 10 is a simplified drawing depicting an alternate approach of the present invention for connecting the handset of a cellular telephone system to the transceiver with an infrared light link according to a fourth embodiment where the handset contains only a speaker and microphone with an IR link and the remaining dialing capabilities and the like are contained in a cradle for the handset which also contains at least one IR link point associated with the transceiver unit.

Description of the Preferred Embodiments:

In issued United States Letters Patent number 4,856,046 entitled REMOTE PUBLIC TELEPHONE LINE by two of the co-

inventors of this application and in co-pending application serial number 541,518, filed 21 June 1990 and entitled ENHANCED INFRARED-CONNECTED TELEPHONE SYSTEM by the same two inventors, various uses of infrared (IR) as a linking light source in telephone systems are shown. This invention is a further refinement of and comprises improvements over the teachings thereof as they specifically relate to the environment of cellular telephones in general and as installed in automobiles in particular.

The present invention in its most basic embodiment is depicted in Figure 3. The handset 20' includes a bi-directional infrared interface 26 operably connected thereto as more fully described in the above-referenced Letters Patent and co-pending application. In the interest of simplicity and the avoidance of redundancy, the infrared interface 26 will not be addressed with any further particularity herein. A similar infrared interface 26 is operably connected in the transceiver unit 22. The functions previously performed by the cord 24 are, therefore, now performed by the infrared interfaces 26.

As shown in Figure 4, it is preferred that the infrared interface 26 of the transceiver unit 22 be physically removed from the transceiver unit 22 so that it can be placed in a convenient place within the area for interfacing with the handset. For example, in an automobile the transceiver unit 22 is often placed under a seat or under the dashboard while it would be better for operational purposes if the infrared interface 26 was placed in a more elevated position. In this regard, it should be mentioned that the examples contained hereinafter are directed with particularity to use of the present invention in an automobile. In fact, however, it is equally useful in any vehicle (including boats and airplanes) as well as in non-vehicular installations such as home or office cellular base stations. Thus, the breadth accorded the claims which follow hereinafter should not be limited by the use of the single exemplary environment; but rather, should reflect the scope and spirit of the invention as a whole. As depicted in Figure 5, it is anticipated that the use of multiple infrared interfaces 26 in association with the transceiver unit 22 may be preferable for manufacturing a single

cellular system which is easily adaptable to various installations. For example, a primary infrared interface 26 could be built into the transceiver unit 22 as shown with a plug-in jack provided at 28 into which at least one auxiliary or supplemental infrared interfaces 26' can be plugged.

The external or supplemental infrared interfaces 26 can be provided in various forms to suit the needs of various users. A first possible type is shown in Figure 6 where it is combined with a through-the-window type of RF antenna 12 for the cellular transceiver unit 22 itself. Such antennas have the antenna 12 connected to a first plate 30 which is adhesively attached on the outside of the window glass 32. A second plate 34 is attached on the inside of the window glass 32 and connected by the cable 36 to the transceiver unit 22. The RF energy is coupled capacitively between the plates 30, 34 with the glass 32 acting as a dielectric. The exterior IR link-point 38 could be molded into the plastic 40 of the antenna system so that the two comprise a single installation. It could, of course, be made as a separate component. The IR link-point 38 comprises an exterior portion 42 and an interior portion 44. The two portions 42, 44 are adhesively attached on opposite sides of the glass 32 in alignment with one another. In this embodiment, the two portions 42, 44 each contain a portions 46 and 46' of a light pipe. The light pipe can be of any type well known in the art such as optical quality glass fibers. The exterior portion 42 has a member with a conical parabaloid reflective exterior surface 48 disposed over the outer end of the light pipe portion 46. The interior portion 44 has a connecting cable 50 connected between the inner end of the light pipe portion 46' and the transceiver unit 22. The cable 50 can be a light pipe as well so as to conduct IR light beams 52 to and from the transceiver unit 22. Alternatively, the cable 50 can be an electrical cable with conversion to and from IR occurring at 52 according to techniques described in detail elsewhere herein. As depicted in Figure 6, with this embodiment IR light beams 52 striking the reflective surface 48 are reflected into the light pipe portion 46 from whence they travel down the portion 46 through the glass 32 and into the portion 46'. IR light beams 52

traveling the opposite direction emerge from the portion 46 from whence they strike the reflective surface 48 and are reflected radially outward to be received by the handset 20'.

A variation of the foregoing approach is shown in Figure 7. In this case, the exterior portion 42 contains a bi-directional infrared interface 26' which is capacitively coupled through the glass 32 by plates 54 to the cable 50 (electrical connection only) in the manner of the antenna 12 and first and second plates 30, 34. With the embodiments of both Figures 6 and 7, if the exterior IR link-point 38 is mounted so as to extend above the roof line, a greater field of access from the handset 20' will be available than if it is mounted lower down on the windshield or rear window. Typically, however, it will be mounted high as most operating manuals advise that preferred operation of the cellular telephone can be obtained by having the antenna 12 extend above the roof line of the vehicle.

With the infrared interface 26 of the handset 20' mounted on the top of the handset 20' as depicted in Figures 3-5, a convenient location for the infrared interface 26 connected to the transceiver unit 22 is in the headliner of an automobile or the like. For such installations, a dual-purpose lamp unit 54 as shown in Figure 8 can be employed to advantage. The unit 54 comprises a plastic case 56 having a clear cover 58 thereover on the side facing the interior of the vehicle. The plastic case 56 is mounted into the headliner 59 as shown. It is divided into a first compartment having a bulb 57 therein and a second compartment containing the infrared interface 26. In this embodiment, the preferred infrared interface 26 is one of the type to be described hereinafter with respect to Figure 9 with particularity in which a conversion takes place such that an IR interface exists with the handset 20' and an electrical interface exists with the transceiver unit 22. Each is connected by separate wires 60, 62 to it respective interface point. The wires 60 connect the infrared interface 26 to the transceiver unit 22 and the wires 62 connect the bulb 57 to a controlled source of electricity for turning it off and on. As thus configured, the infrared interface 26 is

disguised and hidden within the case 56 and the wires 60, 62 can be contained in a common multi-wire cable for ease of wire routing.

A greatly simplified bi-directional infrared interface 26 for both internal and external access (i.e. for roaming) is shown in Figure 9. The approach employed herein could be adapted in the embodiments of Figures 6 and 7, as mentioned earlier, for converting between IR light signals and electrical signals. The infrared interface 26 is built into a small plastic unit 64 having a base 66 which can be attached easily to the dashboard 68 of an automobile, for example, with double-sided foam adhesive tape 70. The unit 64 has a central bulkhead 72 to which a pair of IR transmitter diodes 74 and a pair of IR detecting transistors 76 are mounted on opposite sides. For esthetic and functional reasons, the diodes 74 and transistors 76 are covered by filtering covers 78 of a type well known in the art for such applications. The diodes 74 are connected in common to first wires 80 and the transistors 76 are connected in common to second wires 82. As thus constructed and with the unit 64 attached to the dashboard 68 behind the windshield 84 as shown, there is a first transmitter and receiving portion 86 directed over a field of view outside of and in front of the automobile and a second transmitter and receiving portion 88 directed over a field of view on the inside of the automobile. If desired and to increase the overlapped field of views to allow a user to leave the vehicle during a telephone conversation without losing the IR connecting link, additional diode and transistor pairs 74, 76 can be provided on the bulkhead 72 facing in, for example, the side directions.

Alternate approaches to the present invention are depicted in Figure 10. According to one aspect, the infrared interface 26 connected to the transceiver unit 22 is contained in a cradle 90 for receiving the handset 20'. The handset 20' may also be a "dumb" handset in that it may contain only the necessary speaking and listening components along with its infrared interface 26 with the keyboard 92 for dialing (and any other necessary buttons and/or switches) being located in the cradle 90 as depicted.

Wherefore, having thus described our invention, what is claimed is:

1. In a cellular telephone system comprising a handset connected to a transceiver unit which is connected to a transmitting and receiving antenna, the improvement comprising:

a) first infrared transmitter and receiver unit means built into the handset for converting electrical signals for the transceiver unit into emitted infrared light signals and for converting received infrared light signals as emitted by the transceiver unit into electrical signals; and,

b) second infrared transmitter and receiver unit means connected to the transceiver unit for converting electrical signals for the handset into emitted infrared light signals and for converting received infrared light signals as emitted by the handset into electrical signals.

2. The improvement to a cellular telephone system of claim 1 wherein:

said second infrared transmitter and receiver unit means is contained within a common housing with the transceiver unit.

3. The improvement to a cellular telephone system of claim 1 wherein:

said second infrared transmitter and receiver unit means is removed from the transceiver unit and connected to the transceiver unit with a connecting cable.

4. The improvement to a cellular telephone system of claim 3 wherein:

said connecting cable is an electrical cable.

5. The improvement to a cellular telephone system of claim 3 wherein:

said connecting cable is a light pipe.

6. The improvement to a cellular telephone system of claim 3 wherein:

the transceiver unit includes means for removeably connecting said second infrared transmitter and receiver unit means thereto.

7. The improvement to a cellular telephone system of claim 3 wherein:

a) the transceiver unit is located within an enclosure; and,

b) said second infrared transmitter and receiver unit means is mounted outside of said enclosure.

8. The improvement to a cellular telephone system of claim 7 wherein:

a) said enclosure comprises an automobile; and,

b) said second infrared transmitter and receiver unit means comprises,

b1) a first portion mounted on an external surface of a glass member of said automobile,

b2) a second portion mounted on an internal surface of said glass member of said automobile, and wherein,

b3) signals pass through said glass member between said first portion and said second portion.

9. The improvement to a cellular telephone system of claim 8 wherein:

said first portion and said second portion each include a light pipe therein and said signals pass through said glass member between said first portion and said second portion as light signals conducted by said light pipe.

10. The improvement to a cellular telephone system of claim 9 wherein:

said first portion includes means for reflecting incoming light beams from the handset into said light pipe and for reflecting light beams emerging from said light pipe towards the handset.

11. The improvement to a cellular telephone system of claim 8 wherein:

a) said first portion and said second portion each include a capacitive plate adhesively attached to said glass member;

b) said first portion includes means for converting incoming light beams from the handset into electrical signals applied to said capacitive plate thereof and for converting electrical signals received by said capacitive plate thereof into light beams; and,

c) said signals pass through said glass member between said first portion and said second portion as capacitively-coupled electrical signals.

12. The improvement to a cellular telephone system of claim 3 wherein:

said second infrared transmitter and receiver unit means includes means for converting incoming light beams from the handset into electrical signals output thereby and means for converting electrical signals received from the transceiver unit into light beams output thereby.

13. The improvement to a cellular telephone system of claim 12 wherein:

a) said means for converting incoming light beams from the handset into electrical signals output thereby comprises at least two light detecting transistors facing in different directions to be responsive to light entering from respective ones of different fields of view; and,

b) said means for converting electrical signals received from the transceiver unit into light beams output thereby comprises at least two light emitting diodes facing in different directions to direct said light beams toward respective ones of said different fields of view.

14. The improvement to a cellular telephone system of claim 3 wherein:

said second infrared transmitter and receiver unit means is mounted in a common housing in combination with an illumination light producing source whereby said second infrared transmitter and receiver unit means is disguised and hidden within said housing.

15. The improvement to a cellular telephone system of claim 14 wherein:

said second infrared transmitter and receiver unit means includes means for converting incoming light beams from the handset into electrical signals output thereby and means for converting electrical signals received from the transceiver unit into light beams output thereby.

16. A light-connected cellular telephone system comprising:

a) a handset;

b) a transceiver unit;

c) a transmitting and receiving antenna connected to said transceiver unit;

d) first infrared transmitter and receiver unit means built into said handset for converting electrical signals for said transceiver unit into emitted infrared light signals and for converting received infrared light signals as emitted by said transceiver unit into electrical signals; and,

e) second infrared transmitter and receiver unit means connected to said transceiver unit for converting electrical signals for said handset into emitted infrared light signals and for converting received infrared light signals as emitted by said handset into electrical signals.

17. The light-connected cellular telephone system of claim 16 wherein:

said second infrared transmitter and receiver unit means is contained within a common housing with said transceiver unit.

18. The light-connected cellular telephone system of claim 16 wherein:

said second infrared transmitter and receiver unit means is removed from said transceiver unit and connected to said transceiver unit with a connecting cable.

19. The light-connected cellular telephone system of claim 18 wherein:

said connecting cable is an electrical cable.

20. The light-connected cellular telephone system of claim 18 wherein:

said connecting cable is a light pipe.

21. The light-connected cellular telephone system of claim 18 wherein:

said transceiver unit includes means for removeably connecting said second infrared transmitter and receiver unit means thereto.

22. The light-connected cellular telephone system of claim 18 wherein:

a) said transceiver unit is located within an enclosure; and,

b) said second infrared transmitter and receiver unit means is mounted outside of said enclosure.

23. The light-connected cellular telephone system of claim 22 wherein:

a) said enclosure comprises an automobile; and,

b) said second infrared transmitter and receiver unit means comprises,

b1) a first portion mounted on an external surface of a glass member of said automobile,

b2) a second portion mounted on an internal surface of said glass member of said automobile, and wherein,

b3) signals pass through said glass member between said first portion and said second portion.

24. The light-connected cellular telephone system of claim 23 wherein:

said first portion and said second portion each include a light pipe therein and said signals pass through said glass member between said first portion and said second portion as light signals conducted by said light pipe.

25. The light-connected cellular telephone system of claim 24 wherein:

said first portion includes means for reflecting incoming light beams from said handset into said light pipe and for reflecting light beams emerging from said light pipe towards said handset.

26. The light-connected cellular telephone system of claim 23 wherein:

a) said first portion and said second portion each include a capacitive plate adhesively attached to said glass member;

b) said first portion includes means for converting incoming light beams from said handset into electrical signals applied to said capacitive plate thereof and for converting electrical signals received by said capacitive plate thereof into light beams; and,

c) said signals pass through said glass member between said first portion and said second portion as capacitively-coupled electrical signals.

27. The light-connected cellular telephone system of claim 18 wherein:

said second infrared transmitter and receiver unit means includes means for converting incoming light beams from said handset into electrical signals output thereby and means for converting electrical signals received from said transceiver unit into light beams output thereby.

28. The light-connected cellular telephone system of claim 27 wherein:

a) said means for converting incoming light beams from said handset into electrical signals output thereby comprises at least two light detecting transistors facing in different directions to be responsive to light entering from respective ones of different fields of view; and,

b) said means for converting electrical signals received from said transceiver unit into light beams output thereby comprises at least two light emitting diodes facing in different directions to direct said light beams toward respective ones of said different fields of view.

29. The light-connected cellular telephone system of claim 18 wherein:

said second infrared transmitter and receiver unit means is mounted in a common housing in combination with an illumination light producing source whereby said second infrared transmitter and receiver unit means is disguised and hidden within said housing.

30. The light-connected cellular telephone system of claim 29 wherein:

said second infrared transmitter and receiver unit means includes means for converting incoming light beams from said handset into electrical signals output thereby and means for converting electrical signals received from said transceiver unit into light beams output thereby.

31. The light-connected cellular telephone system of claim 16 and additionally comprising:

a) a cradle for removably holding said handset; wherein,

b) said second infrared transmitter and receiver unit means is built into said cradle.

32. The light-connected cellular telephone system of claim 31 wherein:

said handset is a dumb handset and dialing means associated with the cellular telephone system are located in said cradle and connected to said transceiver unit by a connecting cable.

33. In a cellular telephone system comprising a handset connected to a transceiver unit which is connected to a transmitting and receiving antenna, the method of construction and operation to facilitate mobility of the handset comprising the steps of:

a) incorporating a first infrared transmitter and receiver unit means into the handset for converting electrical signals for the transceiver unit into emitted infrared light signals and for converting received infrared light signals as emitted by the transceiver unit into electrical signals;

b) connecting a second infrared transmitter and receiver unit means to the transceiver unit for converting electrical signals for the handset into emitted infrared light signals and for converting received infrared light signals as emitted by the handset into electrical signals; and,

c) during operation of the cellular telephone system, transmitting signals between the handset and the transceiver unit as infrared light signals.

34. The method of claim 33 and additionally comprising the step of:

positioning the second infrared transmitter and receiver unit means at a location removed from the transceiver unit.

35. The method of claim 34 where the cellular telephone system is installed in a vehicle with the transceiver unit located inside of the vehicle and wherein said step of positioning the second infrared transmitter and receiver unit means at a location removed from the transceiver unit comprises:

positioning the second infrared transmitter and receiver unit means at a location on the outside of the vehicle.

36. The method of claim 34 where the cellular telephone system is installed in a vehicle with the transceiver unit located inside of the vehicle and wherein said step of positioning the second infrared transmitter and receiver unit means at a location removed from the transceiver unit comprises:

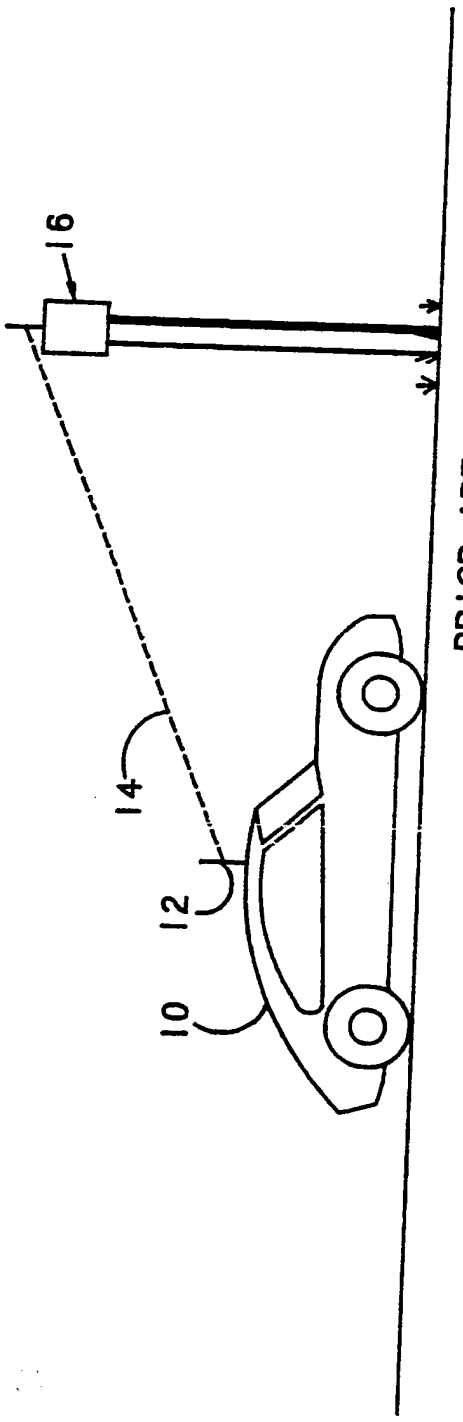
positioning the second infrared transmitter and receiver unit means at a location on the inside of the vehicle to receive light signals from the handset when it is located inside of the vehicle and to receive light signals from the handset through a glass member of the vehicle when it is located outside of the vehicle.

37. The method of claim 34 where the cellular telephone system is installed in a vehicle with the transceiver unit located inside of the vehicle and wherein said step of positioning the second infrared transmitter and receiver unit means at a location removed from the transceiver unit comprises:

positioning the second infrared transmitter and receiver unit means in a headliner portion of the vehicle.

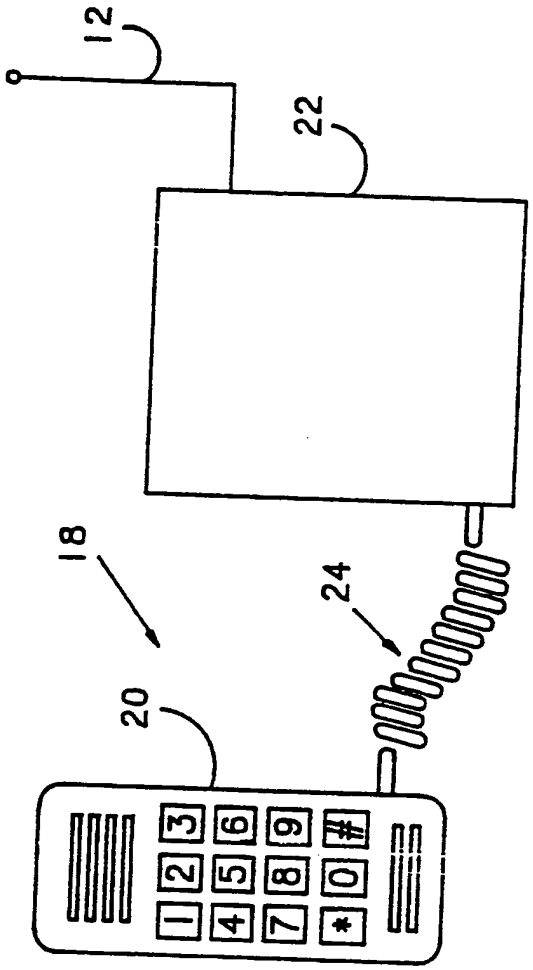
38. The method of claim 34 where the cellular telephone system is installed in a vehicle with the transceiver unit located inside of the vehicle and wherein said step of positioning the second infrared transmitter and receiver unit means at a location removed from the transceiver unit comprises:

positioning the second infrared transmitter and receiver unit means in a common housing in combination with an illumination light producing source whereby the second infrared transmitter and receiver unit means is disguised and hidden within the housing.



PRIOR ART

FIG. 1



PRIOR ART

FIG. 2

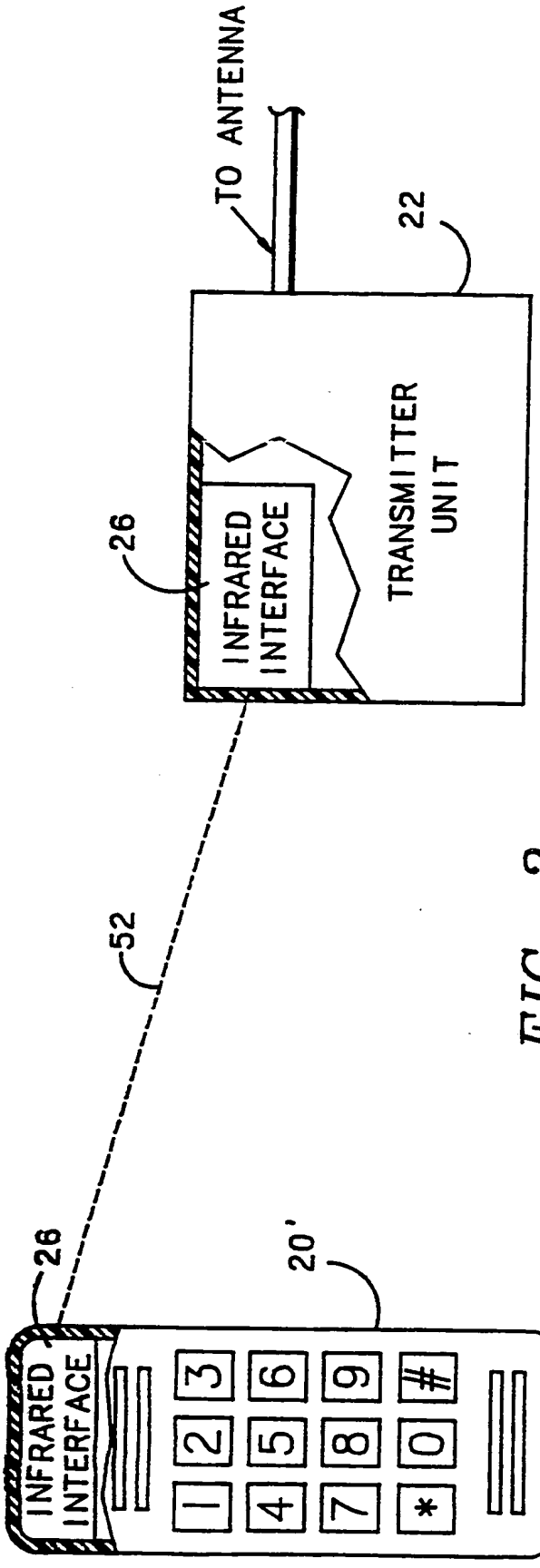


FIG. 3

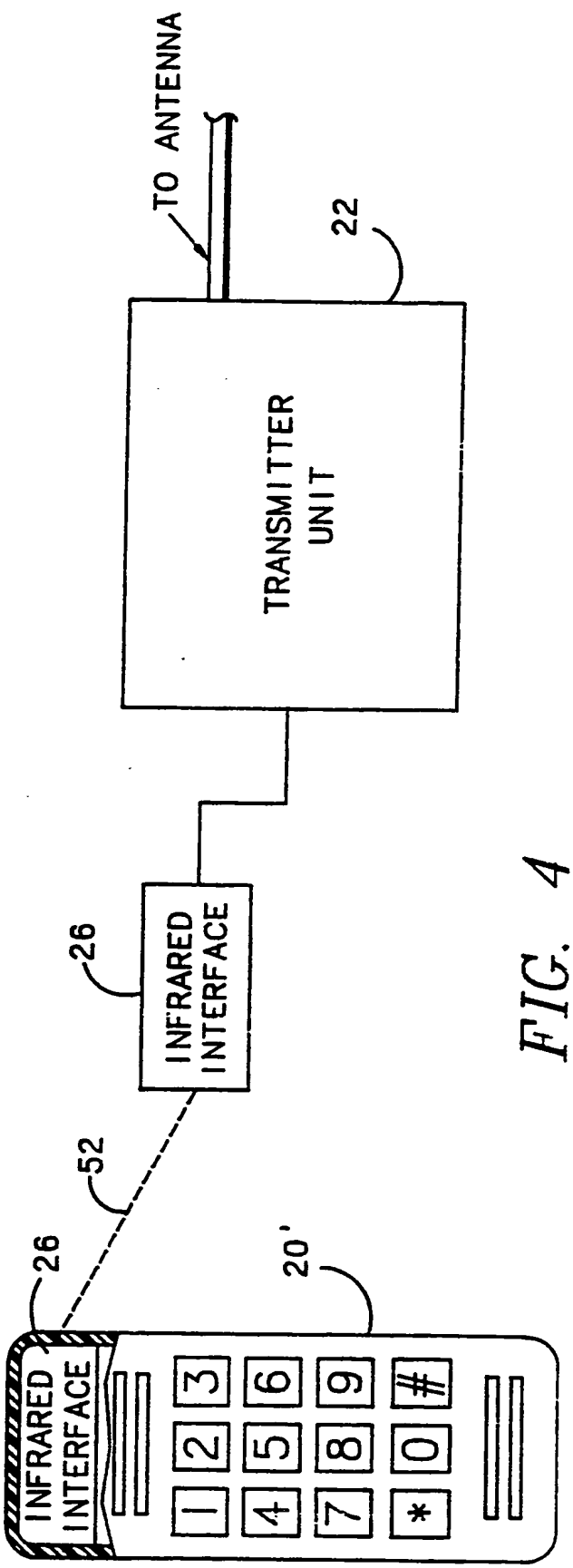


FIG. 4

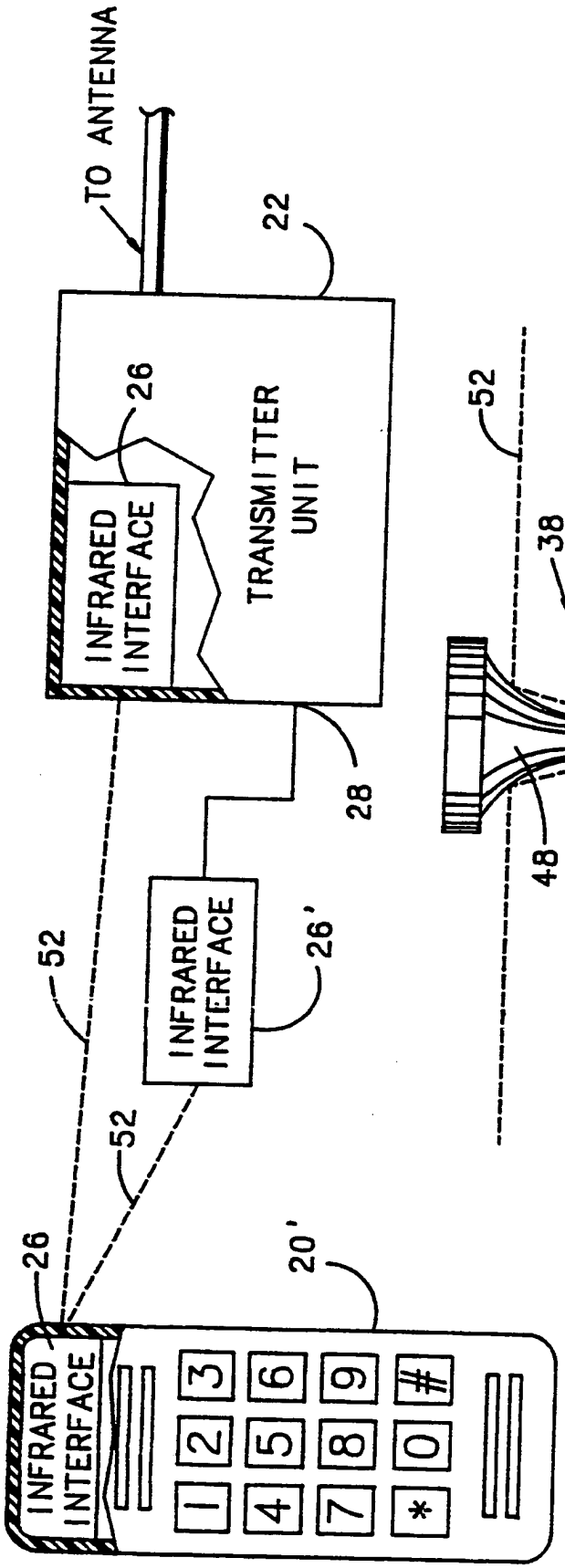


FIG. 5

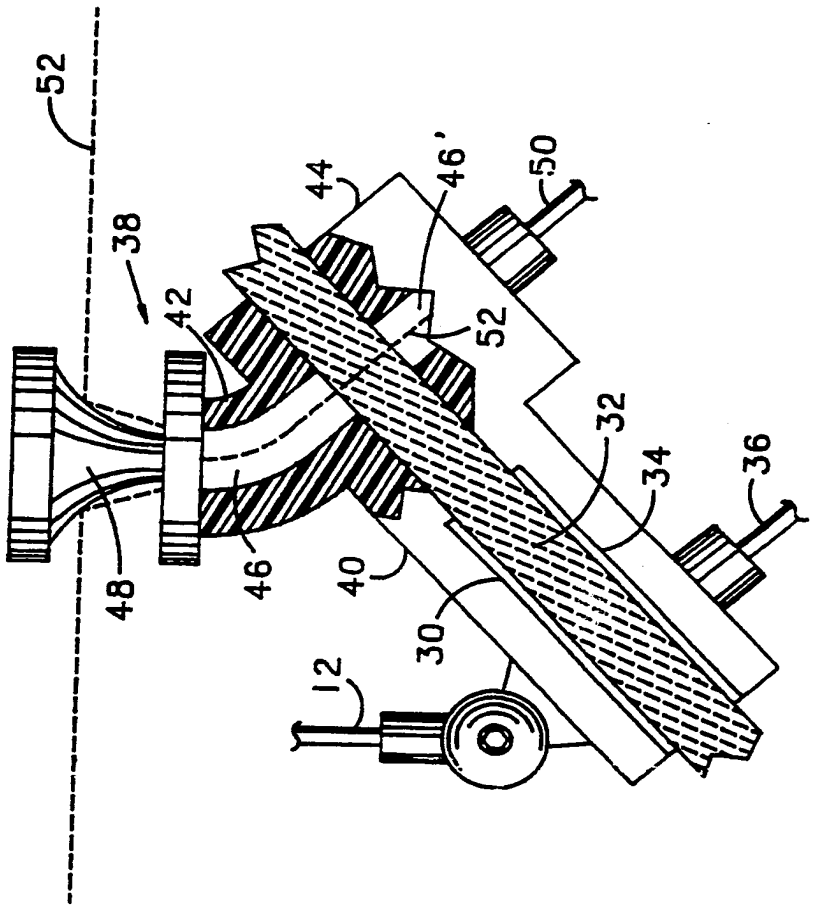


FIG. 6

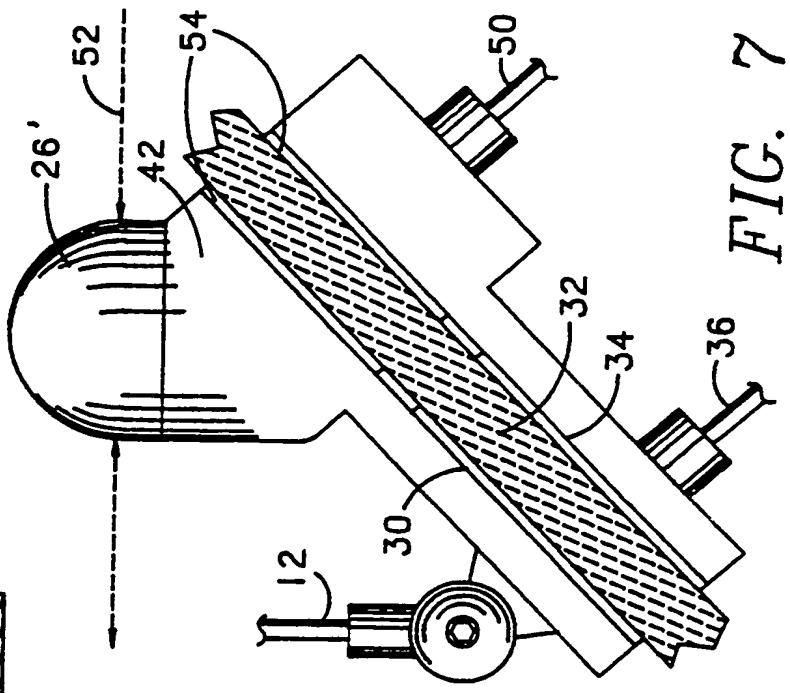


FIG. 7

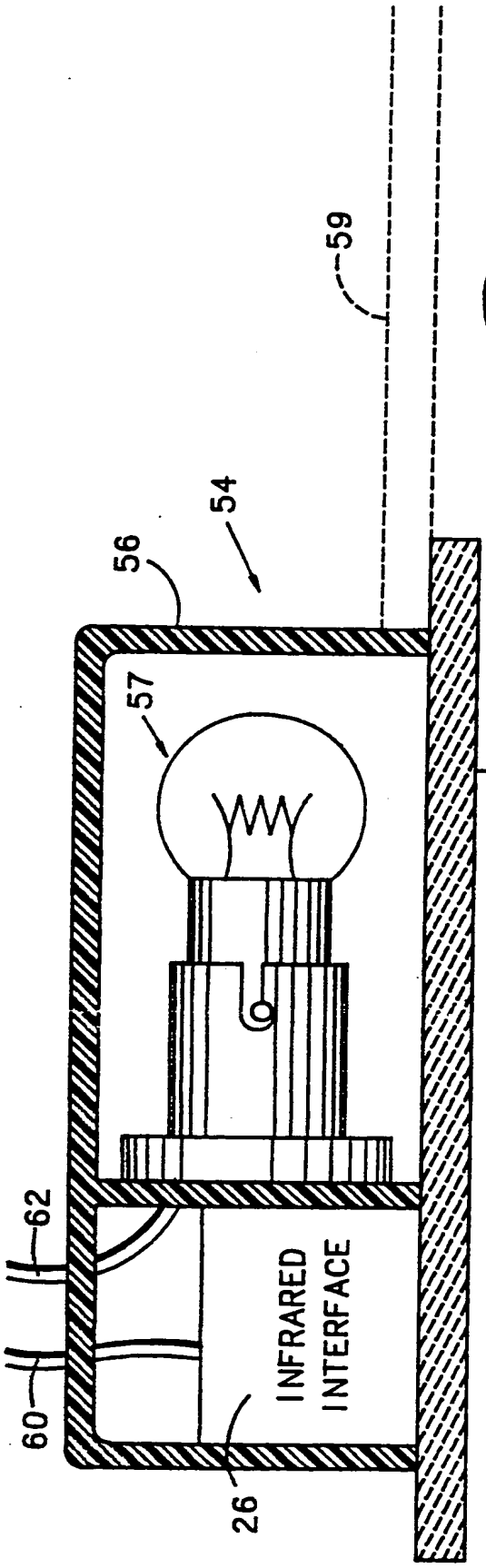


FIG. 8

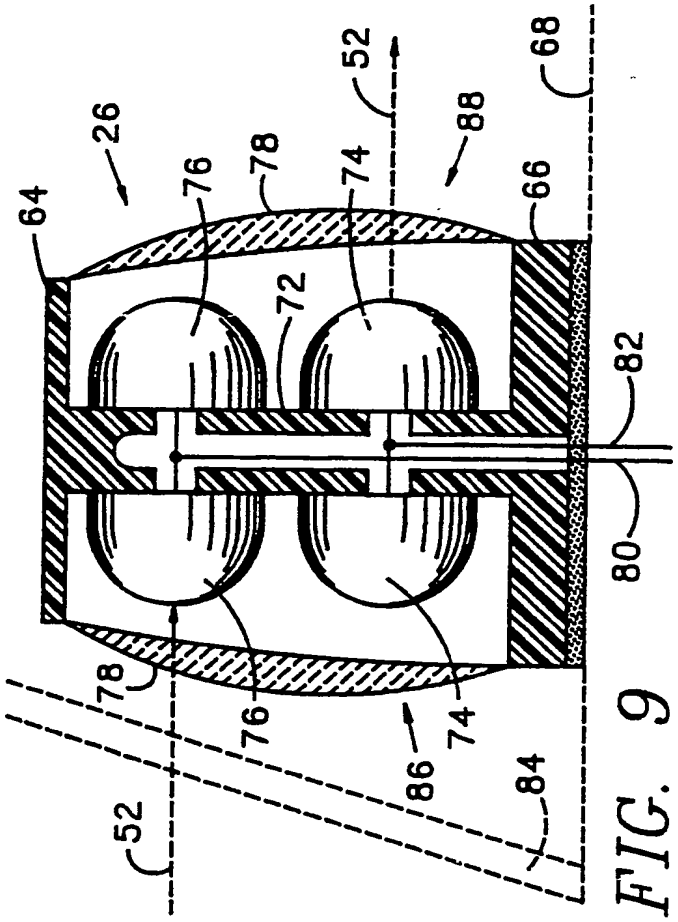


FIG. 9

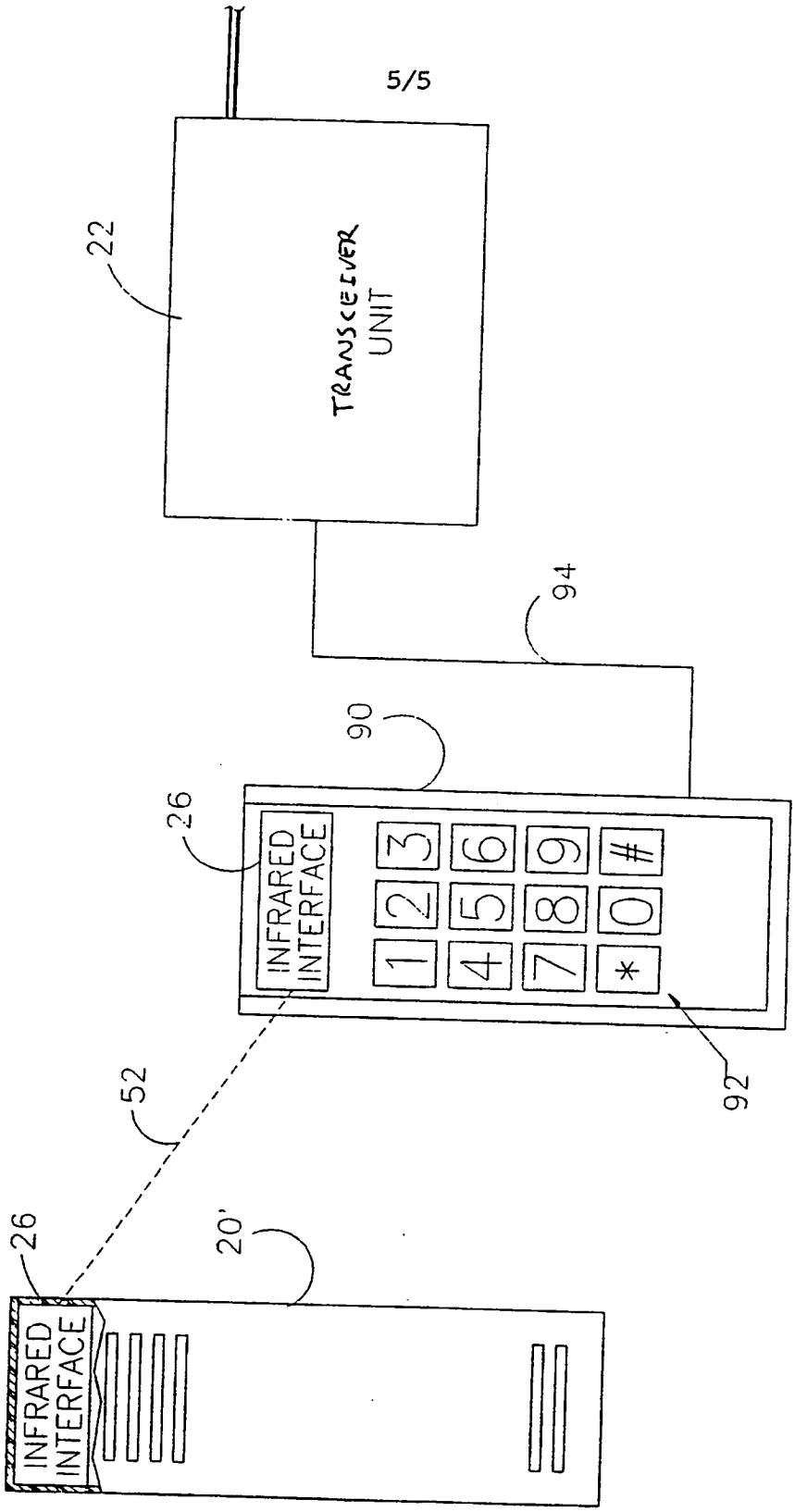


FIG. 10

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/06583

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5) H04M 11/00
US CL 379/56; 343/715; 359/154

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
US	379/56,58,59,61,63,144; 359/109,141,145,149,154 343/713,715,725

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 4,629,828 (UMEBAYASHI) 16 DECEMBER 1986 See figure 1	1-5,7,12,14-20,22, 29-31,33,34,37,38
Y	US, A, 4,456,793 (BAKER ET AL) 26 JUNE 1984 See figufe 1,3; column 4, lines 59-64; column 5, lines 13-26, 53-56	1-7,12,16-22,27,33, 34
A	US, A, 4,931,806 (WANDERLICH) 05 JUNE 1990 See abstract	11,26
A	US, A, 4,931,805 (FISHER) 05 JUNE 1990 See abstract	11,26
Y	JP, A, 2-27854 (SASAKI) 30 JANUARY 1990 See English Abstract, Figure 4.	1,2,16,17,31-34
Y	JP, A, 62-102651 (SAKURAGI) 13 MAY 1987 See English Abstract, figures 1-3	1,2,16,17,31,34
Y	US, A, 4,757,553 (CRIMMINS) 12 JULY 1988 See Abstract, figure 1, figure 3, figure 4.	1,2,13,16,17,28,33
E,A	US, A, 5,060308 (BIEBACK) 22 OCTOBER 1991 See Abstract; figure 6,7	8,9,23,24

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20 NOVEMBER 1991	24 DEC 1991
International Searching Authority	**Signature of Authorized Officer**
ISA/US	DWAYNE BOST

Form PCT/ISA/210 (second sheet) (Rev.11-87)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

Y	DAK Industries Incorporated advertisement, "Split Personality", Fall 1984, page 53.	32
P,A	US, A, 4,980,926 (NOETEEL) 25 DECEMBER 1990 See abstract, figures 1-8.	8,9,23,24
A	US, a, 4,829,561 (MATHENY) 09 MAY 1989 See Abstract, figures 1-4	1-38

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers . because they relate to subject matter [1] not required to be searched by this Authority, namely:

2. ☐ Claim numbers . because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [1], specifically:

3. ☐ Claim numbers_____, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4 ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.